Ontario
Ministry of Natural Resources
Hon. Alan W. Pope
Minister
W. T. Foster
Deputy Minister

ONTARIO GEOLOGICAL SURVEY

Open File Report 5457

Aggregate Resources Assessment, District Municipality of Muskoka.

1983

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by

Staff of the Algonquin Region

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E.G. Pye, Director
Ontario Geological Survey

FOREWORD

This report and accompanying maps present the results of a preliminary investigation of the sand and gravel resources in the District Municipality of Muskoka. The field investigation of Muskoka reveals that some areas have acute shortages of natural aggregate while other areas have a relative abundance of material. The objective of this inventory is to ensure that the areas of high resource potential are utilized to the maximum benefit to ensure a continuing supply of aggregate material in the area.

E.G. Pye, Director
Ontario Geological Survey

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INTRODUCTION

Because sand and gravel deposits are fixed location, non-renewable resources with high bulk and low unit value, resource management strategies are required to make the best use of available resources in a region. The PIanning Department of the District Municipality of Muskoka is presently in the process of amending their District Official Plan. As one component of the amendment process, the Planning Department requested that a detailed inventory of aggregate resources be undertaken within the municipality. This task, jointly funded by the Municipality and the Ministry of Natural Resources, Algonquin Region, has produced a series of maps which delineate and assess potential aggregate resources. These maps provide a comprehensive inventory of the sand and gravel resources data acquired from previous work, data interpretation and preliminary field work.

This report is a technical background document which accompanies the inventory maps. It is designed to describe all inventory methods, explain the presentation and interpretation of the data and make recommendations regarding the suitability of the aggregate resources in the municipality.

Information for some of the granular deposits is incomplete because of time and budget constraints.

OBJECTIVE

The objective of the inventory is to provide background information that identifies areas of high aggregate resource potential. The identification of these resources has been designed to assist in land-use planning exercises.

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METHODOLOGY

The inventory was carried out in four sequential stages.

Stage 1 Information Acquisition

A literature search of previous work focussed on the engineering and terrain map produced by Mollard (1979), the surficial mapping of Chapman and Putnam (1975), the unpublished data collected by D. Sharpe for the Ontario Geological Survey (personal communication), the Ministry of Natural Resources' (Algonquin Region) pit inventory of 1978 and 1979 and information on file in the Geotechnical Section of the Ministry of Transportation and Communications, North Bay.

Stage II Aerial Photograph Interpretation

Black and white aerial photographs with the approximate scale of 1:37,000 (flights flown in 1969 and 1976) were examined and features with sand and gravel potential were transferred to the NTS 1:50,000 topographic maps.

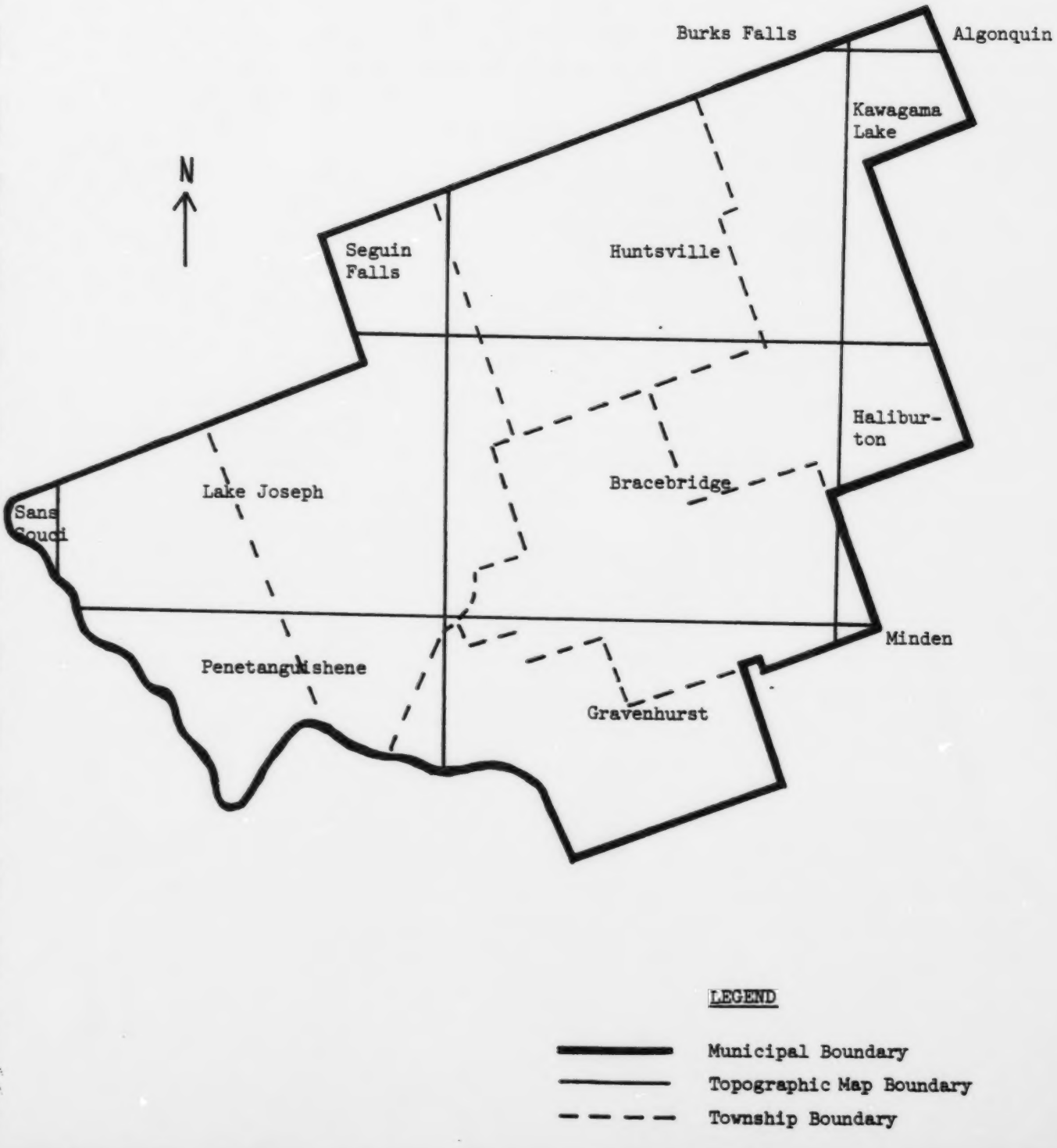
Stage III Field Investigations

Reconnaissance mapping in the District Municipality of Muskoka involved the examination of most pits and as many potential aggregate deposits as time and accessibility permitted. Observations made at pit sites included estimates of the total face height and the proportion of gravel- and sand-size fragments in the deposit. Observations were also made of the shape and lithology of the particles. Seismic refraction geophysics lines, were run on a few high potential aggregate deposits to obtain vertical dimensions.

Stage IV Map Preparation

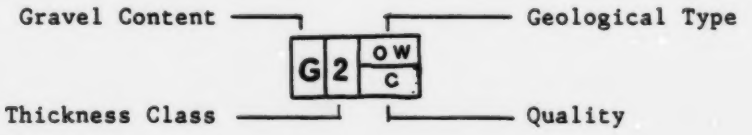
Having compiled all information, maps were prepared. Interpretive boundaries of the aggregate units have been drawn on each of the twelve 1:50,000 scale NTS topographic maps which extend over the District Municipality of Muskoka (Figure 1).

FIGURE 1 -- THE STUDY AREA
(NTS map titles shown)



DATA PRESENTATION AND INTERPRETATION

Adjacent to most deposits indicated on the maps is the Deposit Symbol, adopted from the classification used by the Ontario Geological Survey in their aggregate resource inventory series. The Deposit Symbol is similar to those used in soil mapping and land classification systems commonly in use in North America. The components of the symbol indicate the gravel content, thickness of material, origin (type), and quality limitations for a given deposit. These components are illustrated by the following example:



This symbol identifies an outwash deposit 10 to 20 feet (3 to 6 m) thick containing more than 35 percent gravel. Excess fines may limit uses of the aggregate in the deposit.*

The "gravel content" and "thickness class" are basic criteria for distinguishing different deposits. The "gravel content" symbol is an upper case "S" or "G". The "S" indicates that the deposit is generally "sandy" and that gravel-sized aggregate makes up less than 35 percent of the whole deposit. "G" indicates that the aggregate probably contains 35 percent or more gravel.*

The "thickness class" indicates a depth range which is related to the potential resource tonnage for each deposit. Four thickness class divisions have been established as shown in the legend of each map.*

Two similar sets of letters, divided from each other by a horizontal line, follow the thickness class number. The upper series of letters identify the type of geologic deposit (see Appendix) and the lower series of letters identify the main quality limitations that may be present in the deposit.* In some cases, the Deposit Symbol is incomplete. Where the gravel content, thickness of material, or origin symbols are missing from the box, adequate information was not available.

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* Taken from the Ontario Geological Survey Aggregate Resources Inventory Paper 53, 1982; Part II.

The shading scheme applied to the distribution map is an interpretative scheme derived from an evaluation of the deposits. Three levels of significance are identified; primary, secondary, and tertiary.

Aggregate resource areas of primary significance are indicated by Letratone screen #LT54, thus . These deposits are not permanent, single land use units which must be incorporated in an official planning document. They represent areas in which a major resource is known to exist and may, therefore, be reserved wholly or partially for extractive development and/or resource protection within the context of the official plan.*

Deposits of secondary significance are indicated by Letratone #LT221 applied diagonally to the map, thus . Although deposits of secondary significance are not considered to be the "best" resource areas in the municipality, they may contain large quantities of sand and gravel and should be considered an integral component of the aggregate supply of the municipality.

Areas of tertiary significance are indicated by Letratone #LT214 applied horizontally to the map, thus . These deposits are not considered to be important resource areas because of their low available resources, or because of possible difficulties in extraction. Such areas may be useful for local needs but are unlikely to support large-scale development.*

Areas delineated by a boundary with no applied shade indicate a potential resource where insufficient information is available to assess its significance.

The process by which deposits are evaluated and selected involves site specific criteria only. These selection criteria are related to the characteristics of individual deposits such as deposit size, aggregate quality and to a limited extent location and setting.

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* Taken from the Ontario Geological Survey Aggregate Resources Inventory Paper 53, 1982; Part II.

Deposit Size

Ideally, selected deposits should contain available sand and gravel resources large enough to support a commercial pit operation using a stationary or portable processing plant. In practice, much smaller deposits may be of significant value depending on the overall reserves in the rest of the municipality. Generally, deposits thicker than 20 feet (6 m) and containing more than 35 percent crushable gravel are considered to be the most favourable for commercial development. Hence, these deposits are of primary significance. Thinner deposits may be more valuable in municipalities with low total resources.*

Aggregate Quality

The limitations of natural aggregates for various uses results from variations in the lithology of the particles composing the deposit and from variations in the size distribution of these particles.*

Four indicators of the quality of aggregate may be included in the Deposit Symbol adjacent to deposits on the maps. They are: gravel content (G or S); fines (C); oversize (O); and lithology (L).*

Three of the indicators deal with grain size distribution. The gravel content (G or S) indicates the suitability of aggregate for various uses. Deposits containing more than 35 percent crushable gravel are considered to be favourable extractive sites, since this content is the minimum from which crushed products can be economically produced.*

Excess "fines" or high silt and clay content may severely limit the potential use of an aggregate. Fines content in excess of 10 percent may impede drainage in road sub-base aggregate and render it more susceptible to the effects of frost action. In asphalt aggregate, excess fines hinder the bonding of particles.*

Deposits containing more than 20 percent "oversize" particles [those greater than 4 inches (10 cm) in diameter] may also have use limitations. The oversize component is unacceptable for all concrete aggregate and for road-building aggregate, so must be either crushed or removed during processing.*

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* Taken from the Ontario Geological Survey Aggregate Resources Inventory Paper 53, 1982; Part II.

The fourth indicator of the quality of an aggregate is "lithology". Various lithologies of particles in a sand and gravel deposit determine its suitability for various uses. The presence of objectionable lithologies such as chert, siltstone and shale plus weathered igneous and metamorphic rocks, can result in a reduction in the quality of an aggregate, especially for high-quality uses.*

If the Deposit Symbol indicates either "C" "O" or "L", or any combination, the quality of the deposit is considered to be reduced for some uses of the aggregate. No attempt has been made to quantify the degree of limitation imposed. Assessment of the four indicators is made from published data, from data contained in files of the Ontario Ministry of Transportation and Communications, from the Ontario Ministry of Natural Resources' Algonquin Region's pit inventory and from field observations.

Location and Setting

The location and setting of a resource area has a direct influence on its value for possible extraction. In this project, the evaluation of a deposit's setting has been based on natural features which permanently constrain the development of a site rather than man-made features which currently "sterilize" sand and gravel deposits.

Natural, physical constraints on extractive development include features such as thick overburden, high water table, and bedrock outcrops. These render a deposit less valuable owing to the difficulties presented in resource recovery. That is, the greater the constraint, the lower the potential significance of a deposit.

Man-made features, on the other hand, such as roads, railways, and housing developments built on a deposit, have not been included in the evaluation. These structures may limit or prohibit extractive development; and in terms of land-use planning decisions, sterilization is an important concern. However, the maps are a geological data base for identifying aggregate resources and as such, existing land uses did not influence the levels of significance identified. For the same reason, land ownership did not influence data base information. Furthermore, the amount of material removed from an extractive site has not been taken into

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* Taken from the Ontario Geological Survey Aggregate Resources Inventory Paper 53, 1982; Part II.

consideration in the assessment. Sites which have been identified as primary significance on the basis of Ministry of Transportation and Communications specification data, for example, may have since been worked extensively, and consequently, been depleted or lowered in significance. Therefore, caution must be exercised when interpreting the amount of high quality aggregate remaining in the municipality.

Regional Significance

In selecting sufficient areas for resource protection, it is important to assess both the local and the regional resource base and to forecast future production and demand patterns. The aggregate resources in the region surrounding a municipality should be assessed in order to properly evaluate specific resource areas and to adopt optimum resource management plans. For example, a municipality that has large resources in comparison to its surrounding region constitutes a regionally significant resource area. Municipalities with large resources in proximity to large demand centres, such as metropolitan areas, are special cases.*

Although an appreciation of the regional context is required to develop comprehensive resource management techniques, such a detailed evaluation is beyond the scope of this report. The assessment of resource areas made in this study is based primarily on geological data or on considerations outlined in preceding sections.*

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* Taken from the Ontario Geological Survey Aggregate Resources Inventory Paper 53, 1982; Part II.

RESULTS

(1) In general, the broad lowlands in the region are primarily glaciolacustrine plains comprised of sand, silt and clay. Meltwater channelled between bedrock knolls and meltwater entering proglacial lakes had the potential to deposit significant amounts of higher quality material. Therefore, raised features such as sand and gravel terraces, outwash deltas and some ice-contact deposits have higher potential for aggregate extraction.

(2) There is an acute shortage of natural sand and gravel within the Township of Georgian Bay. Also, the Township of Muskoka Lakes and all but the north portion of the Town of Gravenhurst contain very limited aggregate reserves. A "glacial scouring" action west of Bracebridge and Gravenhurst extending across most of the Penetanguishene and Lake Joseph sheets was responsible for these shortages. Here the eroding action of glacial ice removed surficial material and left an exposed and scraped bedrock surface. A consideration in these areas could be the protection of potential quarry sites for processing bedrock-derived crushed stone of the granitic gneiss type. Certainly, protection of natural aggregate resources in these regions is required.

(3) The Township of Lake of Bays and, especially the Towns of Huntsville and Bracebridge, have appreciable high quality sand and gravel reserves. The area occupied by the Highway 11 corridor was a major spillway channel for glacial meltwaters during the melting and retreat of the continental ice masses. The main geomorphic features are deltas, fans and other outwash deposits associated with the spillway. The high quality deposits should be examined closely to permit extraction to their maximum potential.

(4) All areas of sand and gravel designated as primary significance, that have not been sterilized, should be considered for protection.

Deposits designated as secondary significance should receive at least partial protection, especially where the availability of adequate

resources on a regional scale are lacking. Although there is an abundance of granular fill in the form of lacustrine sands, some tertiary deposits may require protection as a fill source. This will prevent high quality deposits from being used where only low specifications are called for. In future years, these tertiary deposits may well be of greater importance.

(5) Considering the limited time available for this project, the results obtained were of a high quality, although the need for additional detail in the future was clearly demonstrated.

Limited funding for the project restricted the use of refraction seismic surveying, electromagnetic conductivity surveying, backhoeing and power auger drilling. These expensive forms of testing could certainly enhance the accuracy of the data.

Furthermore, there is a subjective element inherent in this inventory. Often, the decision upon which a deposit's significance was based was made on limited information. For example, a visual examination of a pit face or road cut revealing fine silty sand may, in fact, be underlain by undetected higher grade aggregate. Decisions may have been based upon outdated information. Also, deciding upon where a line was drawn to separate levels of significance was in many cases a value judgement made by the author; not geological fact. Therefore, the lack of test results and quantitative data on a large number of deposits is responsible for this subjective element.

CONCLUSION

This aggregate assessment prepared for the District Municipality of Muskoka and the Ministry of Natural Resources, Algonquin Region provides background information designed to assist planners in their designation and protection of high potential sand and gravel resource areas. Where important land-use decisions must be made which would preclude the possible future extraction of aggregates (i.e. residential, commercial and industrial development), site specific investigations may have to be carried out.

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Ontario Geological Survey
1981: Aggregate Resources Inventory of Amaranth Township, Dufferin County. Ontario Geological Survey, Aggregate Resources Inventory Paper 53, 32 p., 6 tables, 3 maps, scale 1:50,000.

APPENDIX -- GEOLOGY OF SAND AND GRAVEL DEPOSITS *

The type, distribution, and extent of sand and gravel deposits in southern Ontario are the result of extensive glacial and glacially influenced activity in Wisconsinan time during the Pleistocene Epoch, approximately 7000 to 85 000 years ago. The deposit types reflect the different depositional environments that existed during the melting and retreat of the continental ice masses, and they can readily be differentiated on the basis of their morphology, structure, and texture. The deposit types are described below.

GLACIOFLUVIAL DEPOSITS

These deposits can be divided into two broad categories: those that were formed in contact with (or in close proximity to) glacial ice, and those that were deposited by meltwaters carrying materials beyond the ice margin.

ICE-CONTACT TERRACES (ICT)

These are glaciofluvial features deposited between the glacial margin and a confining topographic high, such as the side of a valley. The structure of the deposits may be similar to that of outwash deposits, but in most cases the sorting and grading of the material is more variable and the bedding is discontinuous due to extensive slumping. The probability of locating large amounts of crushable aggregate is moderate, and extraction may be expensive due to the variability of the deposits both in terms of quality and grain-size distribution.

KAMES (K)

Kames are defined as mounds of poorly sorted sand and gravel deposited by meltwater in depressions or fissures on the ice surface or at its margin. During glacial retreat, the melting of supporting ice causes collapse of the deposits producing internal structures characterized by bedding discontinuities. The deposits consist mainly of irregularly bedded and cross-bedded, poorly sorted sand and gravel. The present forms of the deposits include single mounds, linear ridges (crevasse fillings) or complex groups of landforms. The latter are occasionally described as "undifferentiated ice-contact stratified drift" (IC) when detailed subsurface information is unavailable. Since kames commonly contain large amounts of fine-grained material and are characterized by considerable variability, there is generally a low to moderate probability of discovering large amounts of good-quality, crushable aggregate. Extractive problems encountered in these deposits are mainly the excessive variability of the aggregate and the presence of excess fines (silt- and clay-sized particles).

ESKERS (E)

Eskers are narrow, sinuous ridges of sand and gravel deposited by meltwaters flowing in tunnels within or at the base of glaciers, or in channels on the ice surface. They vary greatly in size. Many, though not all eskers consist of a central core of poorly sorted and stratified gravel characterized by a wide range in grain size. The core material is often draped on its flanks by better sorted and stratified sand and gravel. The deposits have a high probability of containing a large proportion of crushable aggregate, and since they are generally built above the surrounding ground surface, are convenient extraction sites. For these reasons esker deposits have been traditional aggregate sources throughout southern Ontario, and are significant components of the total resources of many areas.

Some planning constraints and opportunities are inherent in the nature of the deposits. Because of their linear nature, the deposits commonly extend across several property boundaries leading to unorganized extractive development at numerous small pits. On the other hand, because of their form, eskers can be easily and inexpensively extracted and are amenable to rehabilitation and sequential land use.

UNDIFFERENTIATED ICE-CONTACT STRATIFIED DRIFT (IC)

This designation may include deposits from several ice-contact, depositional environments which usually form extensive, complex landforms. It is not feasible to identify individual areas of coarse-grained material within such deposits due to their lack of continuity and grain-size variability. They are given a qualita-

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* Appendix taken from the Ontario Geological Survey Aggregate Resources Inventory Paper 53, 1982.

APPENDIX CONT'D.

tive rating based on existing pit and other subsurface data.

OUTWASH (OW)

Outwash deposits consist of sand and gravel laid down by meltwaters beyond the margin of the ice lobes. They occur as sheets or as terraced valley fills (valley trains) and may be very large in extent and thickness. Well developed outwash deposits have good horizontal bedding and are uniform in grain-size distribution. Outwash deposited near the glacier's margin is much more variable in texture and structure. The probability of locating useful crushable aggregates in outwash deposits is moderate to high depending on how much information on size, distribution and thickness is available.

ALLUVIUM (AL)

Alluvium is a general term for clay, silt, sand, gravel, or similar unconsolidated material deposited during postglacial time by a stream as sorted or semi-sorted sediment on its bed or on its floodplain. The probability of locating large amount of crushable aggregate in alluvial deposits in low, and it has generally low value due to the presence of excess silt and clay-sized material. There are no large postglacial alluvium deposits in Ontario.

GLACIOLACUSTRINE DEPOSITS

GLACIOLACUSTRINE BEACH DEPOSITS (LB)

These are relatively narrow, linear features formed by wave action at the shores of glacial lakes that existed at various times during the deglaciation of southern Ontario. Well developed lacustrine beaches are usually less than 20 feet (6 m) thick. The aggregate is well sorted and stratified and sand-sized material commonly predominates. The composition and size distribution of the deposit depends on the nature of the underlying material. The probability of obtaining crushable aggregate is high when the material is developed from coarse-grained materials such as a stony till, and low when developed from fine-grained materials. Beaches are relatively narrow, linear deposits, so that extractive operations are often numerous and extensive.

GLACIOLACUSTRINE DELTAS (LD)

These features were formed where streams or rivers of glacial meltwater flowed into lakes and deposited their suspended sediment. In southern Ontario such deposits tend to consist mainly of sand and abundant silt. However, in near-ice and ice-contact positions, coarse material may be present. Although deltaic deposits may be large, the probability of obtaining coarse material is generally low.

GLACIOLACUSTRINE PLAIN (LP)

The nearly level surface marking the floor of an extinct glacial lake. The sediments which form the plain are predominantly fine to medium sand, silt, and clay, and were deposited in relatively deep water. Lacustrine deposits are generally of low value as aggregate sources due to their fine grain size and lack of crushable material. In some aggregate-poor areas, lacustrine deposits may constitute valuable sources of fill and some granular base course aggregate.

GLACIAL DEPOSITS

END MORAINES (EM)

These are belts of glacial drift deposited at and parallel to, glacier margins. They commonly consist of ice-contact stratified drift and in such instances are usually called kame moraines. Kame moraines commonly result from deposition between two glacial lobes (interlobate moraines). The probability of locating aggregates within such features is moderate to low. Exploration and development costs are high. Moraines may be very large and contain vast aggregate resources, but the location of the best resource areas within the moraine is usually poorly defined.

EOLIAN DEPOSITS

WINDBLOWN FORMS (WD)

Windblown deposits are those formed by the transport and deposition of sand by winds. The form of the deposits ranges from extensive, thin layers to well developed linear and crescentic ridges known as dunes. Most windblown deposits in southern Ontario are derived from, and deposited on, pre-existing lacustrine sand plain deposits. Windblown sediments are almost invariably composed of fine to coarse sand and are usually well sorted. The probability of locating crushable aggregate in windblown deposits is very low.

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